MIT Kavli Institute for Astrophysics and Space Research
Research Restart Plan

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Executive Summary

1. MKI will act in accordance with all government and MIT guidelines. We advise medically vulnerable employees, anyone who is not ready to be at MIT, or anyone who is able to work productively and satisfactorily to telework. Once MIT has approved ramp-up, we will consider phased restart when:
   • Mitigation has been ongoing for at least ~12 weeks from its start date of March 13, and
   • Community R0 > 1 is excluded at >90% confidence over a 1-week period, and
   • The Estimated Daily Count of COVID-19 cases in MA (corrected for testing deficiencies in the UW model) is below 100 cases per 100,000 residents, corresponding to a <15% probability of a single MKI community member falling ill or coming to work while sick.

2. Bathrooms
   • Until further notice all bathrooms in MKI space will be single occupancy
   • Between-visit air filtration times will be calculated and posted for each bathroom using the methods described in Section 2.1. HVAC fans will be run at high settings with maximum allowed fraction of fresh / outside air mixed in. Typical wait times are 5 minutes for normal use, 30 minutes after a coughing individual, and 1 hour after a sneezing individual
   • Bathroom doors should be left open when not occupied to promote ventilation. Where possible we will make door modifications to simplify this.
   • MKI is in communication with MIT facilities, with a goal to replace as many fixtures (faucets, soap, towel dispensers) as possible to be no-touch operation.
   • MKI is working to provide safe-to-enter signals for bathrooms through either timed motion sensors in series with light fixtures, or small door-triggered timers.

3. Co-working in shared offices is not feasible in the short-term future. Offices with multiple desks will need to be scheduled in shifts, and appropriately disinfected.

4. Office and lab space staffed in shifts should be scheduled to leave a minimum 1 hour break between shifts, and occupants should cover and/or disinfect high-touch areas of their office (e.g. mouse, keyboard) at the start and end of each shift.

5. The safest place to schedule meetings is outdoors, and Kavli will investigate ways to purpose our outdoor areas for safely distanced seating.

6. If meetings are limited to 1 hour with 5-10 empty minutes between for filtration, it may be possible to have safe, small gatherings in HEPA clean tents. There must be a demonstrated demand for such a capability before implementing.

7. Use of elevators will be restricted to one person at a time, with occupancy signs posted.

8. Face masks are required in all MKI indoor and outdoor spaces, including labs, bathrooms, and corridors, but excluding single-occupancy offices. Individuals are responsible for selecting and procuring their own masks. References are provided on mask options and fit.

9. Employees who are sneezing and/or coughing are instructed to stay at home until symptoms pass, even if the sneezing is caused by other factors such as seasonal allergies

10. MKI will use the MIT-wide app for health self-monitoring as part of our building access plan.

11. Community members returning to campus must agree to report possible symptoms of COVID-19 to MIT Medical, and comply with Medical's advice and directives on testing. If notified that a community member working on campus is sick, MKI will work with MIT Medical and public health officials to initiate contact tracing following best practices for privacy and confidentiality.
12. We will instruct custodians not to enter individual offices or labs as they would normally do to empty trash buckets and vacuum. Occupants can initiate trash collection by placing bins outside their office at the end of their shift, and request vacuuming through MKI's facilities manager.

There are many unknowns about COVID-19 and no analysis can credibly certify a perfect understanding of risk, or better yet eliminate all risk when resuming activity. Our best-effort analysis indicates that if these guidelines are followed, the probability of contracting COVID-19 in the workplace is lower than that of exposure from other routines necessary for daily life. The technical methods used to arrive at this conclusion are documented in Sections 2 and 5 for interested readers.

This document and its contents are under revision control and will evolve in response to changes in public health guidelines, MIT policy and restart guidance, and MKI members’ experience operating within these new bounds. We expect revisions to occur regularly over the next year and welcome suggestions for improvement during the ramp-up.
MKI Plan for Research Restart

**Purpose:** This document specifies MKI’s approach for repopulating our research and student spaces. Our objective is to accomplish this in a controlled manner that balances the need to protect members of our community from contracting COVID-19, with the need to continue the activities of research, education, engineering, and development that are central to MKI's mission.

**Requirements:**
- R1: MKI’s plan shall conform with applicable laws, and guidance of CDC and MIT
- R2: MKI shall provide a best-effort quantitative estimate of risk in different workplace environments, and take measures to mitigate these risks where appropriate
- R3: MKI shall document the basis of risk estimates, track, and communicate updates
- R4: MKI shall implement a response plan in the event that an on-campus worker reports symptoms and/or a positive test for COVID-19

**Goals:**
- G1: No members of the MKI community will contract the novel coronavirus in our workplace
- G2: All employees/affiliates who want to work on campus will be accommodated in a shift by September 1, 2020
- G3: Community members choosing to stay home will be able to work with productivity approaching that of the office, and foster professional mentoring relationships

**Boundary Conditions**
- B1: During the period of reduced density, no one at MKI will require any personnel to come to campus if they feel unsafe

1. **External Guidelines on Restart**

1.1. **CDC Guidelines and interpretation of “when mitigation is required”**

The US Center for Disease Control has issued a flowchart to guide decisions about the reopening of workplaces, reproduced in Figure 1. MKI will follow this decision tree on top of MIT guidance. We will at no time adopt a more aggressive opening strategy than MIT as a whole, but we may act more conservatively when appropriate. The majority of our restart plan concerns the safeguards outlined in Columns 2 and 3, which we are attempting to put in place.

Column 1 contains questions to establish whether basic conditions for restart have been met. The second two bullets in this column are easily addressed.

MKI will only open when instructed by MIT that we would be in compliance not only with guidelines from the State of MA and City of Cambridge, but also our internal policies (R1 above). We will look to the office of the Vice President for Research, who has convened a “lightning team” to work on these policies for MIT.

MKI will be ready to protect employees at higher risk of severe illness or complications by instructing them to work from home (B1).
The first bullet in Column 1 of the CDC flowchart is more difficult to interpret. What is “significant mitigation” and when is it required? We interpret mitigation as the public health policy activated when containment – i.e. testing, quarantining and contact tracing – has failed and officials choose to absorb economic penalties to prevent unchecked community spread. MA and MIT entered a condition of mitigation on March 13, 2020.

The CDC has developed a Pandemic Severity Index assessment that rates epidemics on a scale of 1 to 5, and COVID-19 ranks in its most severe category. During a Level 5 event, a mitigation period of 12 weeks is recommended, corresponding to a reopen target of June 13. This is Operational Definition #1 of how long mitigation is required: approximately 12 weeks, or ~June 13.

Other operational definitions use statistical data about transmission and caseload in MA. This information is aggregated in multiple locations, but MKI will use data on the MA-specific caseload reported at the University of Washington Institute for Health Metrics and Evaluation. 

2 https://covid19.healthdata.org/united-states-of-america/massachusetts
and data on the basic reproduction number $R_0$ reported at the Rt.live website\(^3\). Links on these sites reference the assumptions made in data collection, assumptions underlying their calculations, and in some cases relevant open-source Jupyter notebooks.

This leads to **Operational Definition #2**: Mitigation is no longer required when one can exclude $R_0 > 1$ at a probability of > 90% over a 1-week period. When $R_0 > 1$, the caseload accelerates exponentially and a single individual is expected to spread sickness rapidly. The threshold of $R_0 < 1$ has already been met in MA, but must be monitored.

Finally, we can use caseload counts to develop **Operational Definition #3**: the daily count of Estimated COVID-19 cases (from the UW model) falls below 100 cases per 100,000 population for 1 week. With this definition, assuming a binomial distribution for 150 MKI employees with $p = 100 / 100,000$, the cumulative probability of one or more Kavli personnel falling ill\(^4\) falls to 14%. MA first reached the 100:100,000 level on May 21. Note that the “Estimated COVID-19 Case” count includes corrections for incompleteness from individuals who were sick but never tested.

**Summary**: MKI will act in accordance with all government and MIT guidelines (R1), and protect vulnerable employees through telework (B1, G3). We will consider mitigation measures complete (R2, R3) when:

- Mitigation has been ongoing for at least ~12 weeks, and
- Community $R_0 > 1$ is excluded at >90% confidence over a 1-week period, and
- The Estimated Daily Count of COVID-19 cases in MA (corrected for testing deficiencies in the UW model) falls below 100 cases per 100,000 residents, corresponding to a <15% probability of a single MKI community member falling ill or coming to work while sick

### 1.2. MIT Guidelines

MIT has launched a pilot research ramp-up (RRU) study on a limited number of campus spaces, to test recommendations of a Lightning Task Force chaired by Tyler Jacks and charged by the VPR to develop safe campus-wide guidelines for restart. Details on this plan are available at [https://research.mit.edu/research-resources/covid-19-related-information-mit-research-community/guidance-dlcs-and-pis-related-lab-specific-ramp-planning](https://research.mit.edu/research-resources/covid-19-related-information-mit-research-community/guidance-dlcs-and-pis-related-lab-specific-ramp-planning) and MKI will proceed in accordance with all guidelines it sets forth.

Major elements of the VPR’s RRU plan include (1) a form for personnel to acknowledge that they come to campus voluntarily, were not coerced, and agree to virus testing and contact tracing; (2) a detailed two-stage process for PIs to allocate space and on-campus hours to members of their group during RRU, and (3) enhanced EHS training. MKI has already begun item (3) and will be reaching out to EHS representatives from each lab. Relevant lab PIs who will return to campus in RRU Phase 1 have already submitted their Exercise A forms and had them reviewed by MKI. Those groups have been given spreadsheets to fill out for Exercise B. PIs who have not completed an Exercise A spreadsheet need not plan personnel schedules (Exercise B) at this time.

We strongly encourage everyone to read and consider the Acknowledgement Form for voluntary return to campus. PIs should not ask team members about their thoughts or try to

\(^3\) [https://rt.live/](https://rt.live/)

\(^4\) `scipy.binom.sf (0, 150, 100/100,000)`
influence their decision on whether to return. The decision rests with the employee, and PIs will be notified of replies by MIT after forms have been submitted online.

2. Safety-Related Considerations for Kavli’s Physical Plant

Following state guidelines, MKI’s safety strategy involves multiple tiers: (a) opening during periods of low caseload, (b) telework and self-monitoring for symptoms, (c) masks, (d) occupancy management, and (e) vigilance about hazards in the workplace. Any one of these strategies in isolation has uncertainties, but when practiced together with high compliance they appear to prevent community spread. This section describes how Kavli is managing topic (e) above, with special attention to risks from building air quality and bathrooms.

The discussion on aerosol transmission draws heavily from a study by Matt Evans, which is linked separately.

2.1. Air Handling Systems and Ventilation

Airborne aerosols appear to be a primary transmission mechanism for COVID-19, so proper HVAC configuration is the most important facilities aspect of planning for safe return to work. The MKI building HVAC systems are antiquated, but they do have some room for adjustment.

Absent a virus-shedding individual, the aerosolized virus concentration in a room decays exponentially with a time constant dictated by both the aerosol decay rate (~2 hours for COVID) and the air change time in the room, which is typically much shorter (~10 mins), and is set by HVAC power and proportions of fresh and recirculated air. Because of the age and topology of our HVAC systems, the likelihood of cross contamination between offices on the same manifold is thought to be less than the risk of sharing offices, or using bathrooms.

2.1.1. Bathroom Air

First we consider air cycling in bathrooms. If an infected individual occupies the restroom for a period of ~10 minutes and then leaves, how long must one wait before it is safe to enter and breathe the air?

The probability of infection for the second individual scales with the viral dose $D$ received:

$$P_{\text{inf}} = 1 - e^{-D} \approx D \quad [D \lesssim 0.5]$$

We examine the HVAC system burden to meet the requirement of keeping of $D \ll 0.1$, even in an interaction with a highly-contagious individual (top 10%).

Suppose the bathroom air of volume $V_{\text{room}}$ is cycled at rate $r_{\text{room}}$ (specified for HVAC systems in cubic feet per minute, or cfm), leading to a refresh timescale $\tau_{\text{room}} = V_{\text{room}} / r_{\text{room}}$. This time scale is a reciprocal of the standard HVAC specification “Air Changes Per Hour” or ACPH. The viral dose for a second occupant entering at time $t_1$ and staying (conservatively) until $t = \infty$ is:

$$P_{\text{infection}} \approx D \approx \frac{\rho_0}{N_{\text{inf}}} \frac{V_{\text{src}}}{V_{\text{room}}} \tau_{\text{room}} r_{\text{b}} e^{t_1/\tau_{\text{room}}} \quad [D \lesssim 0.5]$$

Here $\rho_0$ is the concentration of viral particles in saliva (1000 / nL for our “highly-contagious individual”), $N_{\text{inf}}$ is the number of viral particles needed to make lung exposure likely from
aerosols (still uncertain, but $N_{\text{inf}} \sim 1000$ for other coronaviruses), $V_{\text{src}}$ is the volume of aerosols generated by the first occupant, and $r_b$ is the second entrant’s breathing rate (typically 10 L / min).

Scaling to these typical parameters:

$$D \approx 0.03 \times \left( \frac{V_{\text{src}}}{10 \text{ nL}} \right) \left( \frac{\tau_{\text{room}}}{10 \text{ min}} \right) \left( \frac{V_{\text{room}}}{1200 \text{ ft}^3} \right)^{-1} e^{-t_1/\tau_{\text{room}}}$$

Here the source term $V_{\text{src}} = 10 \text{ nL}$ is determined by the typical rate of aerosol generation from breathing (1nL / min) and a 10 minute visit. A single cough generates $O(\sim 100) \text{ nL}$, and a sneeze $O(\sim 1000) \text{ nL}$. MKI’s bathrooms in building 37 are typically ~900 cubic feet. Facilities has contracted with an external testing service to measure airflow rates, finding 8-26 ACPH (median 18.6) in these restrooms, or $\tau = 2.5-7 \text{ minutes}$ (median 3.22).

This suggests that when an occupant is breathing normally, the dose stays below hazardous levels even at $t_1 = 0$, and subsequent visitors may enter the room shortly after. If the first visitor coughs, then a waiting period of 1 air change (~10 minutes) is warranted to allow decay of the viral concentration. If the first visitor sneezes in the restroom, then a waiting period of 4 air changes (~40 minutes) is required.

Table 1 summarizes these recommendations for a representative bathroom. Column 1 indicates wait times as calculated above; Column 2 adds a safety margin so that the dose should be below 0.02, thereby keeping the total dose below 0.1 even after multiple exposures. It also allows time for the HVAC system to mix air in the room, as the analysis above assumes thorough mixing and no local concentrations of aerosols. Mechanisms to signal safe-to-enter times are described in Section 2.2 below.

**Recommendation:** Bathroom wait times will be calculated and posted for each bathroom using the methods employed for Table 1, specific to its square footage and HVAC settings. HVAC fans will be run at high settings with maximum allowed fraction of fresh / outside air in mixture.

<table>
<thead>
<tr>
<th>Condition of prior user</th>
<th>D &lt; 0.1 safe requirement</th>
<th>Recommended Margin</th>
<th>D (dose)</th>
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<tbody>
<tr>
<td>Normal breathing</td>
<td>No waiting required</td>
<td>5 minutes</td>
<td>0.018</td>
</tr>
<tr>
<td>Coughing in bathroom</td>
<td>10 minutes</td>
<td>30 minutes</td>
<td>0.015</td>
</tr>
<tr>
<td>Sneeze in bathroom</td>
<td>35 minutes</td>
<td>1 hour</td>
<td>0.007</td>
</tr>
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**2.1.2. Shared offices and labs**

When a contagious individual is in an enclosed space, they shed virus particles (“virions”) into the surroundings until an equilibrium concentration of virus particles per liter of air is reached, balancing the production rate and the HVAC removal rate. For a highly-contagious individual:

$$\rho_{\text{eq}} = \rho_0 \frac{r_{\text{src}}}{r_{\text{room}}} = 3.5 \text{ virions/liter} \left( \frac{r_{\text{src}}}{10 \text{ nL/min}} \right) \left( \frac{r_{\text{room}}}{100 \text{ cfm}} \right)^{-1}$$
Since the average adult has an inspiratory volume of ~0.5L, this suggests one would inhale 2 virus particles with every breath while co-working. Our requirement is to stay below D ~ 0.1 (100 particles deposited), so a healthy individual could only inhabit the space for 3-5 minutes before exceeding threshold.

The assumed value of \( r_{src} = 10 \text{ nL / minute} \) is characteristic of speaking, since the reason to be in the office is to talk with people. If one is working quietly the density is an order of magnitude lower, and co-working of 30 minutes to an hour may be safe in an office. However in that case most individuals could just as profitably work from home.

**Recommendation:** co-working in shared offices is not feasible in the short-term future. Offices with multiple desks will need to be scheduled in shifts, and appropriately disinfected.

### 2.1.3. Time between shifts

If shared offices or labs are scheduled in shifts, then when the first occupant leaves, the density of virions will decay from its equilibrium value as air is cycled by the HVAC system. In this case, the viral dose experienced by the second occupant after waiting for time \( t_1 \) is:

\[
D \approx \frac{\rho_{eq}}{N_{inf}} r_b \int_{t_1}^{\infty} e^{-t/\tau_{room}} dt = \frac{\rho_{eq}}{N_{inf}} r_b \tau_{room} e^{-t_1/\tau_{room}}
\]

Again inserting typical parameters from above, where Occupant 1 is engaged in conversation:

\[
D \approx 0.35 \ e^{-t_1/\tau_{room}}
\]

The dose will therefore fall below 0.1 in slightly more than one room air cycle time. After 1 hour, \( D = 8e-4 \), and the HVAC system would also have time to clear out possible coughs and roughly one sneeze.

**Recommendation:** office and lab spaces scheduled in shifts should be arranged to leave a minimum 1 hour break between shifts, and occupants should cover and/or disinfect high-touch areas of their office (e.g. mouse, keyboard) at the start and end of each shift.

### 2.1.4. Common Spaces and Meetings

It is apparent from 2.1.2 that increased air filtration (beyond what the building provides) is required if individuals wish to sit and converse in the same room without exchanging aerosols. Sitting > 6 feet apart helps to protect against large droplets that fall to the ground, but not aerosols.

The physical transport of aerosols is dominated by convective currents generated by the HVAC system (diffusion is negligible by comparison). The timescale for convective turnover in the room is

\[
\tau_{convection} \sim L_{room}/v_{HVAC} = 30 \text{ seconds} \left( \frac{L}{20 \text{ ft}} \right) \left( \frac{v}{40 \text{ ft/min}} \right)^{-1}
\]

Here the typical 40 ft / min terminal air velocity (after emerging from the jet and mixing with room air) is a recommended amount to avoid drafts in engineered HVAC systems (ASHRAE
Standard 55-2013), and installers are advised not to exceed 50 ft/min. If meeting participants are closer than 20 ft, then the transport time is accordingly shorter.

Because the convective time scale is ~20x smaller than the HVAC air cycle timescale, aerosols will mix efficiently and be shared between occupants, unless supplementary filtering is introduced.

Typical commercial personal HEPA air filtration systems cycle O(~100) cfm, similar to what is delivered by the HVAC system. While these can help speed filtration in bathrooms, elevators and small offices, single residential HEPA filters do not have enough capacity to meet requirements for safe congregation spaces.

Recommendation: The safest place to schedule meetings is outdoors, and Kavli should investigate ways to purpose our outdoor areas for safely distanced seating.

Because of the particular work done in Kavli labs, we have access to industrial soft-wall cleanroom blowers that move air through HEPA filters at much higher rates. For example, a 2 x 4 foot TerraUniversal cleanroom blower processes 720 cfm with minimum 99.99% filtration - nearly an order of magnitude better than the HVAC system. Our standard soft wall clean rooms are ISO7 / Class 10,000 level, requiring 60-90 ACPH, or one change per 45-60 seconds.

If a meeting with one highly-contagious individual takes place in a soft wall clean room with 5 HEPA blowers each processing 720 cfm, then the equilibrium concentration of virus particles is one virus particle per ten liters of air, 0.1 / L. If the goal is to keep exposure below 100 virions total, and each occupant breathes 10 L / minute, then a meeting of 100 minutes would still be below threshold.

It is not clear that cleanrooms will be desirable locations for meetings given their noise levels, especially given the possible need to speak loudly (which increases aerosol generation).

Recommendation: If meetings are limited to 1 hour with 5-10 empty minutes between for filtration, it may be possible to have safe, small gatherings in clean tents. There must be a demonstrated demand for such a capability before implementing, and plans need to be documented and approved.

A final note on aerosols: the foregoing recommendations were all derived using the requirement of no transmission between individuals, when neither person is wearing a mask that provides effective filtering (e.g., N95) and there is 100% probability that one individual is a highly-contagious (top 10%) COVID-19 carrier. Confidence in the plan’s safety increases when combined with the requirement of only occupying buildings when the probability is low of a single MKI individual being COVID-positive. In other words, the likelihood that one person is sick, and that you are in the room with that one person out of everyone at MKI is low.

2.2. Bathroom Modifications

Bathrooms are a necessary, high-contact environment and a focus of our transmission mitigation efforts. Of the ~20 bathrooms in use by MKI, none have a footprint of >320 square feet.

Recommendation: Until further notice all bathrooms in MKI spaces will be single occupancy.

A list of further specific action items follows:

• Door Policy: We are disabling the automated pneumatic door close mechanisms on all bathroom doors where it is possible to do so. Policy will then be to close the door for
privacy on entering, and leave the door open upon exiting the bathroom. This promotes
improved ventilation / air circulation in bathroom spaces, and also indicates to others
whether the bathroom is occupied / safe to enter.

• **Time Between Use:** For each bathroom we will post information on recommended time
interval between uses, based on air volume, HVAC specifications, and the analysis presented
in Section 2.1.

• **Door mechanism:** Door latches will be disabled and foot pulls will be added on the pull side
of each bathroom door, eliminating the need to manually touch handles

• **Dispensers:** We have requested to MIT Facilities that all soap and paper towel dispensers
not already featuring hands-free operation be replaced with auto-feed models.

• **Sinks:** We have requested to Facilities that all sinks be outfitted with no-touch water valves,
or retrofitted for foot valve operation. We are not sure whether this can be accommodated
but will be pursuing it vigorously.

• **Toilets / Stalls:** We are investigating whether toilets can be outfitted with seats including lids.
While RNA has been found in stool samples, there are no documented cases of COVID-19
transmission via aerosols generated by toilet flushing. Nonetheless since this is a
straightforward fix we will attempt to implement and encourage closure of seat lids prior to
flushing.

• **Disposable seat covers:** will be installed in each bathroom stall

A key question is how people arriving to use the restroom will know that the recommended
time has elapsed and it is safe to enter. We are exploring two approaches in parallel to signal
this to arriving customers. First, we will reprogram existing motion sensors already in series
with our restroom light switches to have a 5-minute timeout, and are requesting to add similar
sensors to bathrooms not currently outfitted. This way, if the light is off, it is safe to enter, but if
the light is on, the restroom was occupied within the last 5 minutes.

Separately we are investigating small sensors that can be attached to the door, that will be
activated when people enter and exit the restroom, resetting a timer. When a final solution is
reached we will update this document with details of the implementation.

### 2.3. Elevators

**Recommendation:** Use of elevators will be restricted to one person at a time.

The risk of aerosol transmission is lower in elevators than in bathrooms, and may be lower than
stairwells. Even though elevators are confined spaces with poor air circulation, the risk scales
with exposure and time, and the time on an elevator is ~20x shorter than for a bathroom visit,
*for both a virus-shedding individual, and also a subsequent passenger* who follows them in the
elevator.

For example, the elevators in Building 37 are 6’8” x 4’, for total volume of approximately 7600
liters. Suppose our representative “highly contagious individual” (top 10%) occupies the
elevator for one 0.5 minute ride, and a subsequent passenger immediately makes a second 0.5
minute trip. If Passenger 1 is breathing normally, they generate 0.5 nL of aerosols, diluted into
7600 L of air. Even in the absence of any air circulation (i.e no removal of virus particles), the
ingested dose for Passenger 2, breathing at 10 L/min for 0.5 minutes is $D = 0.0003$, well below
threshold. If coughs transmit 10x more aerosols, this is still probably within margin; multiple sneezes are borderline but should be low probability for short rides.

MKI will provide floor tape to guide distancing, should a line be needed to manage traffic. Users are discouraged from pressing elevator buttons with bare fingers, and instead encouraged to use of keys, gloves, or other means.

Our elevator vendor has programmed the lifts in 37 so that they will park on the ground floor with doors open when not in use, promoting air ventilation. We are requesting the same for other buildings. The elevators do not have 120V AC service and cannot be used to power small air filters.

2.4. Stairwells

Air circulation in stairwells is a concern, because they must be maintained at positive air pressure to comply with fire code (to minimize smoke or chemical inhalation during emergency egress). Therefore they cannot have their doorways propped open to promote ventilation. Even though there is a much larger volume into which aerosols can be diluted, there are no exit vents and ventilation only occurs when a door is briefly opened, or air escapes around cracks.

Moreover during light exercise individuals will experience heightened respiratory rates, which increases the rate of both virus shedding by the first individual, and inhalation by a second individual. Both individuals also spend slightly more time in the stairwell than in an elevator (though traversals of a single floor are comparable).

In 2.3 we found a low risk of transmission in elevators; stairwells may be similarly low but they are harder to quantify because their air is confined by design, unlike our elevators which have been re-programmed to ventilate between rides.

Our stairwells will remain open. However to minimize the number of close passages between ascending and descending perambulators, we will designate and post preferred directions (up or down) for each staircase in our buildings during normal use. These directions will be for courtesy only and should be overridden during any emergency evacuation.

2.5. Common Spaces

Indoor common areas will be closed for community gatherings for the short term future. We will be actively exploring methods (including use of cleanroom filters) to allow for small face-to-face meetings as Massachusetts transitions to later phases of its reopening plan.

Community kitchens, water coolers, microwaves and coffee machines will be closed for food preparation, but sinks will remain accessible for hand washing.

On-campus researchers should plan to bring ALL of their own food and drink from home: water bottles, coffee, food, and should not expect to microwave food or refill water bottles from coolers. Lunches can be eaten with masks off in individual offices with the doors closed, or outside with company allowing generous social distancing. If either of these two options are not available we encourage workers to schedule their shifts to eat meals and use restrooms at home before or after coming to campus.
2.6. Custodial Rounds / Cleaning Responsibilities

The custodial staff will make rounds each shift to clean high-touch surfaces and common areas. These will include elevator buttons, door handles to the building entrance, door handles to all stairwells, and all bathrooms. For NE-83 this will include card access entrance points in the elevator lobbies of the 4th and 5th floors.

We will instruct that unless specifically requested, custodians do not enter individual offices or labs as they would normally do to empty trash buckets and vacuum. The rationale is that we want to minimize the number of people circulating in each workspace. Occupants who would like their trash emptied should either place the bin outside their office door, or tie the liner bag shut, compress it to minimize volume, and deposit it outside their office door so that custodial staff can dispose. Occupants who would like their carpets vacuumed should arrange with Brian Surette to schedule their specific office as part of custodial vacuuming rounds.

Office and lab occupants are encouraged to clean and disinfect their high-touch areas and surfaces, and to wash hands and use sanitizer. Selection and procurement of sanitizing agents, and office sanitizing regimens will be the responsibility of the occupant.

3. Space Management: Density, Occupancy, Shifts

Per MIT guidelines, MKI will manage access to buildings using the metrics of density per room and occupancy per group. Density is defined in terms of number of square feet per person and is calculated on a room-by-room basis. Occupancy is defined as the percentage of each research group’s members on campus, in terms of the population it would support at fully-staffed capacity. The rationale for managing density is to create conditions where all employees can successfully implement social distancing. The rationale for managing occupancy is to reduce demand on public spaces including bathrooms, elevators, and corridors.

MIT will begin with low targets for density and occupancy, and ramp up over time as more of the economy opens and public health milestones are crossed. The initial targets have not been announced, but we will configure the database assuming starting density of >160 s.f. per person and < 25% occupancy.

The VPR’s office has issued information to lab PIs on a two-step plan for research ramp-up (RR), starting with information on lab layout (VPR’s “Exercise A”) and then following with information on staffing needs (“Exercise B”). MKI’s AO will work with PIs to input their initial allocations and schedules.

4. Community Health Measures and Responsibilities


Hand washing is a key active step that each employee can take to flush COVID-19 out of MKI. We will provide signs directing personnel to hand washing stations in kitchens and bathrooms upon exiting the elevators or other common spaces. These signs will also stress the importance of washing hands after spending time in any public areas.
MIT facilities will station hand sanitizer at the entrance to each property and we will request additional stations to be placed outside each restroom.

The message is that *Kavli’s Responsibility Starts with You*:

- Do your part to wash the virus out for your health
- Do your part for others
- PPE enhances – but does not replace – proper hygiene

### 4.2. Mask Policies

**Recommendation:** Until further notice, face masks are required in all MKI indoor and outdoor spaces, including labs, bathrooms, and corridors, but excluding single-occupancy offices.

This is to maintain compliance with COVID-19 Order 31 from the State of MA, and is consistent with recommendations from MIT and EHS. Persons found outside their office without masks will be asked to leave the building for the day.

We discourage the use of certified N95 or other medical grade masks for any personnel who do not have elevated health risk based on age or underlying conditions. Current state guidelines emphasize the importance of supplying this PPE to medical professionals. However MKI will offer no judgment and will not tolerate any attempts to bully or intimidate other members of the community over their decision to wear or not wear medical grade PPE. This is a very personal choice.

**In the long term, each individual will be expected to assume responsibility for their own mask supply.** Although EHS may procure limited supplies of masks to help in early restart, individuals and groups should not rely on MIT or MKI to supply their mask needs.

To this end, employees are advised to prepare a week’s supply or more of multi-layer cloth face coverings for mouth and nose per CDC guidelines. These should be machine washed regularly.

An Arlington sewing school has published instructions for a more sophisticated cloth mask that incorporates a pocket for filter inserts. These may be prepared with cutout HEPA filter material from HVAC filters or HEPA vacuum bags. While not medical grade, they offer increased protection relative to cloth-only masks at reasonable comfort. A sewing machine is required but hand-stitching may be possible.

Proper fit is an important aspect of mask efficacy, with loose-fitting cloth masks only filtering ~30% of particulates but properly fitting masks filtering 70-80%. Users should check mask fit by forcefully inhaling and exhaling several times on install; the mask should collapse slightly on inhale and expand on exhale with a proper fit. A well-fitting mask should be tight against the chin and not allow air to flow around eye sockets. Double-sided fashion tape can be used to seal problem areas when working for extended periods in high-traffic environments.

MKI is maintaining a small strategic reserve of KN95 masks produced in China for use by the administrative group and urgent temporary needs arising in our labs and offices. If individuals wish to procure commercial-grade KN95 masks similar to those purchased by Kavli’s HQ

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7 [https://www.medrxiv.org/content/10.1101/2020.04.17.20069567v2.full.pdf](https://www.medrxiv.org/content/10.1101/2020.04.17.20069567v2.full.pdf)
rather than fabricating their own, we will facilitate group orders (in batches of 50) and supply to end-users at cost. MKI cannot guarantee the quality or efficacy of these masks.

4.3. Sneezing and Coughing

Recommendation: Employees who are sneezing and/or coughing are instructed to stay at home until symptoms pass, even if the sneezing is caused by other factors such as seasonal allergies.

Because COVID carriers can be asymptomatic, and because coughs produce 10x, and sneezes 100x more virus particles than talking, the logistical measures needed to prevent transmission become impracticable. Employees who are well and at work and begin sneezing and/or coughing should pause their workday, travel home, and continue with telework while monitoring other health indicators.

4.4. Monitoring of MKI’s Community Health

Testing and contact tracing have been cited as key elements of a successful program to combat community spread, and are a recommended part of the CDC reopening guidelines (Figure 1, Column 3). Compliance with CDC and state recommendations mandates a monitoring program, but Kavli does not have the resources or privacy infrastructure in place to support general medical testing.

MIT’s campus-wide Restart team is implementing an app-based check-in system involving a short self-monitoring survey, similar to what has been in place at Boston-area hospitals during the pandemic. Each day that an employee wishes to come to MIT, he or she must log into the app, and answer the questions. Campus access will then be granted (most likely through keycard controls) to healthy individuals. Individuals with symptoms will be advised of medical options and/or directed to MIT Medical for further consultation, and testing if warranted.

Personnel returning to campus must agree to an entry viral screening test before being allowed access, and possibly future periodic screening. In time MIT aims to include serology testing as part of the screening panel, as the sensitivity and specificity of such tests improve.

Recommendation: MKI will use the MIT-wide app-based system for health monitoring as part of our building access plan.

4.5. If a community member becomes sick

The primary goal of this restart plan is to prevent a single member of our community from contracting COVID-19. We must also consider how to react in the unfortunate event that one of us falls ill. An important part of the MIT-wide restart plan is that employees must complete a daily attestation of heath status, and agree to notify and follow directives of MIT medical (including additional virus testing) if they exhibit symptoms.

MKI is not part of this reporting chain and will not request personal health information; any information voluntarily disclosed to us by employees will be treated confidentially. All community members should carefully read the voluntary “acknowledgment form” circulated by the VPR’s office to understand their rights and responsibilities, including privacy protections and waivers. This form must be signed by individuals returning to work on campus.

In the event of a positive test result, Kavli will rely on MIT Medical and public health officials to notify other potentially affected persons who may have been in proximity. We will support
requests from MIT Medical in gathering information needed for that purpose. Potentially exposed individuals will be directed to medical resources to understand options and requirements for testing and/or quarantine.

Provisionally, Kavli operations in an affected building will be temporarily restricted to essential services for 48 hours after last contact to allow for disinfecting of the space. This plan will be re-evaluated and updated periodically.

Recommendation: Community members returning to campus must agree to report possible symptoms of COVID-19 to MIT Medical, and comply with Medical's advice and directives on testing. If notified that a community member working on campus is sick, MKI will support requests from MIT Medical and public health officials to assist in contact tracing following best practices for privacy and confidentiality.

4.6. Commuting and Parking

Until September 1, all MIT parking lots will remain open for use by any ID card holders, free of charge. This is to lower the barrier for employees to come to campus if they feel unsafe on public transportation. It is not known if this policy will be extended further.

Up-to-date information may be found at the MIT parking website:

http://web.mit.edu/facilities/transportation/parking/

5. Risk Tiers, Advisories, Basis of Estimate

The goal of MKI’s restart plan is to create a workplace where researchers feel safe, and in fact are safe at MIT, within reasonable bounds of probability. The strategy mirrors state-wide phased openings with multiple lines of defense: (a) opening during periods of low caseload, (b) telework and self-monitoring for symptoms, (c) masks, (d) occupancy management, and (e) vigilance about hygiene and hazard areas in the workplace.

Each of these in isolation has variable levels of efficacy due to compliance, and details of implementation, but practiced together they reinforce to lower the probability of workplace transmission.

Table 2 shows how this reinforcement works. By splitting the community into “pods” of 25% occupied floors, our workers typically only come into contact or share bathrooms with ~7 other colleagues on their shift (not accounting for gendered restrooms). If the societal case rate is 100 COVID patients per 100,000 people, then the Binomial likelihood that one member of a seven-person pod is COVID-positive is just 0.697% or 1:143. Even then, if one implements the social distancing and occupancy measures described above, a non-masked COVID-positive person should have a < 2% chance of transferring virus to another non-masked member of the same shift. Wearing a mask and washing hands reduces that to < 1%.

These individual factors are listed in the left columns, but their cumulative product is shown at right. Taken together, the joint conditional probability that COVID enters your pod, and that you then contract it in the restroom while wearing a mask is of order 1:15,000. If one then folds in the conditional likelihood of fatality after contracting COVID, then the probabilities become smaller especially for personnel younger than 65 years old.
These are the probabilities for a single encounter; if one came to work 5 days/week for a year with 1:15,000 odds each day, the binomial probability of infection over the full year is 1.7%. Folding in the likelihood of fatality (for COVID-19 in NYC, ranging from 0.06% deaths per infection for healthy <65 year olds, to 5% for 65+ with underlying conditions), we would estimate 1 death per year per 100,000 previously healthy individuals at < 65 years. This is 11x smaller than the mortality rate from auto accidents. For individuals at 65+, the higher fatality rate leads to elevated risk of 34 per year per 100,000 – 3x higher than auto accidents. Accordingly 65+ individuals may prefer to wait until caseloads diminish, or work fewer days at the office, or both.

This does not mean that COVID-19 should be taken lightly – it remains a serious threat and we must remain at a state of heightened vigilance. For example if we had remained at work until April 1 and held a typical MKI colloquium with no distancing, there would have been a 21% chance of an infected individual attending. Over an hour, surrounding attendees would inhale 200-300 virions yielding a high probability of widespread infection.

Even with new measures in place and a reduced case rate, we cannot eliminate risk entirely, but the numbers indicate that in returning to work at the right time and taking measures to prevent transmission, one will not elevate risk in a statistically distinguishable sense from what is experienced by general participation in society.

As the rate of new cases continues to drop, it should become possible to increase occupancy and eventually restart daily rhythms and campus gatherings. MIT has not yet engaged in a values discussion about what level of risk our community is willing to assume to support on-campus research, education and scholarly activity. Decisions may be driven by external factors and other economic forces.